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ABSTRACT

Literature reviews, field observations, and personal contacts were used to identify areas important to interior least terns (Sterna antillarum athalassos), piping plovers (Charadrius melodus), and bald eagles (Haliaeetus leucocephalus) on the 58-mile-long Missouri National Recreational River. Areas were prioritized according to suitability of habitat and recorded use by these species. Thirty-nine miles were classified as Priority I least tern and piping plover nesting habitat; three miles were classified as Priority II and 16 miles as Priority III habitat. Bald eagle habitat was considered separately on both sides of the river (116 miles total); 41 miles of Priority I, 35 miles of Priority II, and 40 miles of Priority III habitat were classified.

Suggestions are made for: 1) acquisition (including easement) of important habitat areas, 2) land management, enhancement, and protection measures of important habitat areas, and 3) public relations and education stategies related to the aquisition and management of those areas. Recommendations are made for further study of endangered and threatened species and their habitats on the MNRR.

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INTRODUCTION

The Missouri National Recreational River (MNRR) was established in 1978 as part of the National Wild and Scenic Rivers System to preserve, in a semi-natural state, the free-flowing characteristics of the Missouri River between Gavins Point Dam, South Dakota (RM 810) and Ponca State Park, Nebraska (RM 752) (U.S. Department of Interior 1979). The MNRR provides a variety of habitat types that have been lost on much of the Missouri River because of reservoir construction, channelization projects, and deforestation. The area contains three major riparian habitat types: cottonwood-dogwood (Populus deltoides-Cornus stolonifera), cottonwood-willow (P. deltoides-Salix spp.) and elm-oak (Ulmus americana-Quercus macrocarpa) forest (Clapp 1977), and a riverine habitat type (Cowardin et al. 1979) featuring sandbars, islands (many dominated by cottonwoods and willows), and a variety of wetlands. These unique habitat remnants support a large diversity of wildlife species.

The Endangered Species Act of 1973, as amended, provides for the protection and enhancement, including acquisition, of habitat important to the survival of any federally threatened or endangered species. The following species occur on the MNRR and are included in the federal threatened and endangered species list: interior least tern (Sterna antillarum athalassos), piping plover (Charadrius melodus), and bald eagle (Haliaeetus leucocephalus). Critical habitat, as defined in section 4(a)(3) of the Endangered Species Act, has not been specified by the U.S. Department of Interior, Fish and Wildlife Service (USFWS) for any of these species.

Interior least terns and piping plovers were classified as endangered and threatened, respectively, by the (USFWS) in 1985 because of declines in the species' populations, distributions, and breeding habitats (USFWS 1985a, USFWS 1985b). Much of the suitable least tern and piping plover breeding habitat on the Missouri River has been lost to channelization and reservoir inundation (Ducey 1981a, Dinsmore 1981). The MNRR, however, retains several areas of habitat suitable for nesting and reproduction of least terns and piping plovers. The MNRR supports the largest sympatric concentration of least terns and piping plovers known to exist in the Great Plains area (Nebraska Game and Parks Commission 1985); the MNRR population represents approximately 10% of the known interior least tern breeding population and about 15% of the known piping plover breeding population in the United States. Least tern and piping plover habitat on the MNRR is, however, subject to human disturbance, vegetative encroachment, and sporadic inundation (Ducey 1981b).

In 1978, bald eagles were listed as threatened or endangered in all of the conterminous states (U.S. Department of Interior 1978). Bald eagle wintering habitat currently exists on the MNRR but is rapidly being lost to bank erosion and deforestation (USFWS 1979). Approximately 16-40 bald eagles are believed to winter on the MNRR annually (Benzon pers. comm.).

This report identifies important habitat areas for nesting least terns, nesting piping plovers, and wintering bald eagles on the MNRR which are recommended for acquisition in the Federal interest. Areas are prioritized according to:

1) suitability of habitat, as determined by literature review and field observations, and
2) recorded use, as determined by literature review, field observations (least terns and piping plovers only), and/or personal contacts.

Recommendations for acquisition (including easement) of prioritized areas within the MNRR are made; acquisition of designated lands could act to preserve and protect habitat important to least terns, piping plovers, and bald eagles. Acquisition would also help to insure proper management and enhancement of these lands.

LITERATURE REVIEW

Least terns and piping plovers

Least terns and piping plovers typically arrive at the MNRR from early to mid-May and begin nest initiation and incubation in late May and early June (Nebraska Game and Parks Commission 1985). Incubation takes from 17 to 22 days for least terns (Ducey 1981b) and from 27 to 31 days for piping plovers (Dinsmore 1981). Least tern young fledge at approximately 20 days of age, while piping plover chicks take about 35 days to fledge (Nebraska Game and Parks 1985). The breeding populations of least terns and piping plovers on the MNRR have been estimated at between 57-110 and 40-160 pairs, respectively, since 1982 (Dinan pers. comm.).

With few exceptions, least terns and piping plovers are sympatric, colonial nesters on the MNRR; both species prefer nesting habitat consisting of unconsolidated sand or pebble substrate in bare to sparsely vegetated areas. Where vegetative coverage is >15%, least terns select areas with average vegetation heights of <40 cm (Carreker 1985). Piping plovers appear to exhibit the same tendency (Dinan pers. comm.).

Both least terns and piping plovers nest primarily on sandbars (frequently flooded wetlands with unconsolidated bottoms) in the MNRR (Dinan pers. comm.), but may nest on beaches (unconsolidated shores) elsewhere on the Missouri River and its tributaries in South Dakota (Higgins pers. comm.). Sandbars and sand islands (infrequently flooded upland habitats) received more emphasis than beaches as potential habitat areas because beaches in the MNRR rarely exhibited suitable habitat, had few recorded nestings, and were more subject to human disturbance and predation.

If suitable habitat is not available because of high water levels during the nest initiation period, least terns and piping plovers may select marginal nesting habitat (Massey and Atwood 1978, Dinan pers. comm.) or postpone nest initiation until water levels recede and suitable habitat is exposed (Hardy 1957, Wycoff 1960, Ducey 1981b, Dinan pers. comm.). Faanes (1983) reported that piping plovers are less restrictive in their habitat requirements than least terns but may be effected by the same environmental problems.

Least terns and piping plovers may return to a particular colony site for several consecutive years (Dinsmore 1981, Carreker 1985). Least terns (Gochfeld 1983, Carreker 1985) and piping plovers (Dinan pers. comm.) may nest in marginal habitat on traditional colony sites where vegetative encroachment has caused deterioration of formerly suitable

habitat.

Least terns feed opportunistically on forage fish within a size range of approximately 2-8 cm. The distance least terns must fly from nesting colonies to foraging areas may be an important component of habitat suitability (Carreker 1985). However, areas on the MNRR which contain forage fish within this size range are numerous and probably do not effect least tern selection of nesting habitat. Piping plover feeding habits are poorly documented; however, marine worms, insects, crustaceans, molluscs, and invertebrate eggs have all been reported in piping plover diets (Dinsmore 1981).

Bald eagles

Bald eagles arrive at the MNRR in early to mid-November, depart from late March through late April (Grewe 1966), and apparently follow a migration schedule similar to that of waterfowl (Spenser 1976). Extensive winter use of the MNRR by bald eagles depends on the availability of open water associated with the mainstem dams on the Missouri River (Dunstan 1970). Eagle use of the Missouri River was rarely recorded before construction of the main stem dams. Presently, eagles are known to congregate in large numbers on the Missouri River as a response to the abundant, accessible, and reliable food source made available by the the open water above and below the dams (Grewe 1966). Benzon (pers. comm.) has reported from 16-40 bald eagles on the MNRR, and Russell (1968) reported as many as 129 bald eagles on the Missouri River from Gavins Piont Dam to Sioux City, Iowa. These censuses were conducted in a single day; winter-long fluctuations in eagle use and the total number of eagles using the MNRR has not been documented.

Wintering eagles are generally scavengers; their primary food sources along the Missouri River in South Dakota and Nebraska are fish and waterfowl carrion. Eagles also consume dead mammals, and other carrion (Steenhof 1976, and Terry 1976) and occasionally take prey items when available (Grewe 1966, Evans 1982). While water remains open, eagles primarily utilize dead fish; after freeze up they utilize other carrion to a greater degree (Steenhof 1976).

On parts of the Missouri River, human disturbance of eagle perching and roosting sites, particularly from snowmobile and boat traffic, has been reported to cause site abandonment (Steenhof 1976, Steenhof 1978). However, eagles often congregate in high human-use areas near the mainstem dams, including Gavins Point Dam.

Only one nesting attempt was recorded on the MNRR (Lock and Schuckman 1973). This attempt occurred about four miles west of Yankton, South Dakota, on the Nebraska side of the river during the winter of 1973. A nest was constructed and copulation was observed; however, no eggs were laid and the nest was later abandoned.

PROCEDURES

Areas of habitat important to least terns, piping plovers, and bald eagles were identified through the use of field investigations, low-level aerial reconnaissance, LANDSAT photography, aerial mosaics, existing literature, and information provided by personal contacts. Surveys of least tern and piping plover nesting colonies on the MNRR have been conducted annually by the Nebraska Game and Parks Commission since 1979. Aerial bald eagle counts have been conducted by South Dakota Department of Game, Fish and Parks and the Nebraska Game and

Parks Commission in coordination with the National Wildlife Federation's mid-winter eagle counts annually since 1961. Information from these surveys was used to identify areas of current and historical use by least terns, piping plovers, and bald eagles.

The USFWS conducted two least tern, piping plover, and bald eagle habitat surveys on the MNRR in 1986 (24-30 June and 4-10 August) using a 16-foot John boat. During these field investigations, the authors observed all sandbars, islands, and banks within the MNRR. Potential least tern and piping plover habitats were observed, and percent vegetation, average height of vegetation, and elevation were estimated for each sandbar. When an area appeared suitable, or if adult least terns or piping plovers were present, the habitat was more closely examined. Numbers of least tern and piping plover nests, eggs, chicks, and adults were recorded at each existing colony. Little observation of actual winter habitat could be made during the June and August surveys; however, habitat features, i.e., forested areas with large trees in close proximity to the river bank, which should provide suitable habitat were observed, and their locations were recorded. All habitat locations were recorded on 1985 aerial photo mosaics (1 in.:2000 ft.) provided by the U.S. Army, Corps of Engineers (COE), Omaha District.

Least tern and piping plover habitat priority designations

Priorities are based on habitat suitability and documented use by least terns and piping plovers. The following criteria were used to establish priorities for least tern and piping plover nesting habitat on the MNRR:

Priority I - Suitable (a) or manageable (b) habitat with a history of colonial use in the last 5 years (since 1981), highly recommended for immediate acquisition;

Priority II - Suitable habitat with no recorded colonial use since 1981, recommended for acquisition in the future;

Priority III - Manageable habitat with no recorded colonial use since 1981, not recommended for acquisition at this time.

Thirty-three miles of the 58-mile-long MNRR were classified as Priority Ia, 6 miles as Priority Ib, three miles as Priority II, and 16 miles as Priority III (Table 1, Maps 1-9).

Suitable habitat on the MNRR is defined as bars or islands of unconsolidated sand and/or pebbles with 0-15% vegetative coverage. The average height of vegetation in suitable habitat should be less than approximately 40 cm. The colony site at RM 770.1 provides a good example of suitable nesting habitat. The sandbar is approximately 3.6 ha; the upstream portion of the sandbar is higher than the downstream portion and the leading edge has more sharply cut shorelines than the trailing edge. Nesting (four active nests) was concentrated on the upstream, middle of the sandbar where vegetative coverage was <1% and elevation averaged approximately 24 cm above the river level on 25 July 1986. Vegetative coverage on the entire sandbar was approximately 4%; however, vegetative encroachment was evident around the edges of the sandbar and in areas of lower elevation.

Manageable habitat on the MNRR is considered as 15-100% vegetated

Table 1. Location, priority, and historical use of least tern and piping plover nesting habitat on the Missouri National Recreational River.

Priority[a]	Location (miles)	Map number[b]	Year of colony use[c]
Ia	RM 805-804 (1)	1	1982,84-86[d]
Ia	RM 803-798 (5)	2	1979-86[d]
Ia	RM 797-796 (1)	2	1981,83-86[d]
Ia	RM 795-793 (2)	3	1980-81, 84-86[d]
Ia	RM 791-789 (2)	4	1982, 85-86[d]
Ia	RM 784-780 (4)	5	1978-81, 85-86[d]
Ia	RM 779-776 (3)	6	1978-86[d]
Ia	RM 775-773 (2)	6	1978-83, 86[d]
Ia	RM 772-769 (3)	7	1979, 81, 83-86[d]
Ia	RM 767-766 (1)	7,8	1979, 86[d]
Ia	RM 765-764 (1)	8	1978-81, 86[d]
Ia	RM 763-761 (2)	8	1980, 83-86[d]
Ia	RM 760-754 (6)	8,9	1978-86[d]
Ib	RM 804-803 (1)	2	1981-86
Ib	RM 792-791 (1)	3	1980-81, 83
Ib	RM 773-772 (1)	6	1983
Ib	RM 769-767 (2)	7	1981, 83-85
Ib	RM 766-765 (1)	8	1985
II	RM 808-806 (2)	1	1978-81
II	RM 798-797 (1)	2	None
III	RM 810-808 (2)	1	None
III	RM 806-805 (1)	1	None
III	RM 796-795 (1)	3	None
III	RM 793-792 (1)	3	None
III	RM 789-784 (5)	3,4	None
III	RM 780-779 (1)	5	None
III	RM 776-775 (1)	6	1981
III	RM 764-763 (1)	8	None
III	RM 761-760 (1)	8	None
III	RM 754-752 (1)	9	None

a Priority Ia=suitable habitat with a history of colonial use since 1981; Ib=habitat currently unsuitable but with a history of colonial use within the last 5 years; II=suitable habitat with no recorded use since 1981; III=no suitable habitat and no colonial use since 1981.
b maps are included in the appendices.
c two or more nests of either or both species on the same sandbar.
Information from Nebraska Game and Parks Commission surveys since 1978.
d Information from Nebraska Game and Parks Commission surveys since 1978 and from field investigations by USFWS and South Dakota Department of Game, Fish and Parks in 1986.

sandbars or islands with substrate similar to that of suitable habitat. Marginal least tern nesting habitat, i.e., >15% vegetative coverage with <40 cm average height of vegetation (Carreker 1985), was also considered as manageable habitat.

Habitat suitability on the MNRR is based on the more restrictive, better-documented requirements of least terns. However, given the sympatric relationship of nesting least terns and piping plovers and their similar habitat requirements, any habitat management beneficial to least terns should also be beneficial to piping plovers.

Bald eagle habitat priority designations

The following is a list of priorities that were assigned to the various bald eagle habitat sites:

Priority I - Extensive recorded use by eagles in winter, immediate acquisition is highly recommended.

Priority II - Some recorded use by eagles in winter, acquisition in the future is recommended.

Priority III - Undetermined eagle winter use but with suitable or potentially suitable habitat, further study should be conducted before acquisition is considered.

Seventeen eagle winter-use areas were identified (Table 2, Maps 1-9). The important criteria in prioritization were 1) knowledge of past eagle use and 2) habitat availability. The degree of bank erosion and proximity to human activity were considered when recommending areas for acquisition, but were not used in classifying habitat priorities.

Diurnal bald eagle winter habitat may be described as an area close to the river (generally within 30m), with large trees (mean dbh=42.3cm), an unobstructed veiw in at least one direction, and protection from natural and human disturbances (Steenhof 1976, Steenhof 1978). Perching trees or branches, which are used for feeding, loafing, and foraging (Evans 1982) should extend over the river (Stalmaster 1976).

Nocturnal eagle roosting areas are often communal and are similar to diurnal habitats. The major differences are that roost sites can be farther from water and are often larger in size than diurnal perching sites. Eagles often select "stout, horizontal branches which extend over the channel opening" as roosting perches (Steenhof 1976). Along the Missouri River, eagles have roosted as far as 29 km up or down the river from feeding areas, though roost sites are generally close to the open channel (Steenhof 1976). Only one nocturnal roost has been recorded in the MNRR area (Terry 1976). It was located on the upstream end of the James River Island and the adjacent South Dakota floodplain (Map 2, Site 4).

DISCUSSION

Proper management and protection of prioritized lands within the MNRR is required to insure the survival and propagation of least terns and piping plovers, as well as, the survival of wintering bald eagles. Federal acquisition of these lands would help assure their proper management and protection. The public should be made aware of the plight of least terns, piping plovers, and bald eagles; they should also

Table 2. Location and priority of bald eagle wintering habitat on the Missouri National Recreational River.

Priority[a]	Location (miles)	Bank[b]	Map number[c]	Site number
I	RM 811-810 (1)	W	1	1[d]
I	RM 801-794 (7)	W	2,3	4
I	RM 794-788 (6)	DS L+R	3,4	5
I	RM 788-787 (1)	DS L	4	6[d]
I	RM 787-781 (6)	W	4,5	8
I	RM 778-777 (e)	DS L	7	11[d]
II	RM 810-806 (4)	DS L+R	1	2
II	RM 805-801 (4)	DS L+R	1,2	3
II	RM 781-780 (1)	DS L	5	9[d]
II	RM 777-772 (5)	DS L	6,7	12
II	RM 775-772 (3)	DS R	6,7	12
II	RM 766-761 (5)	W	8	14
II	RM 764-763 (f)	DS L	8	15[d]
III	RM 810-754 (3[g])	DS R	4,6,8	7
III	RM 780-777 (3)	DS L+R	5,6	10
III	RM 772-766 (6)	W	7,8	13
III	RM 760-754 (6)	DS L	8,9	16
III	RM 760-751 (10)	DS R	8,9	16
III	RM 754-751 (3)	DS R	9	17[d]

a Priority I=extensive recorded use by bald eagles; II=some recorded use by eagles; III=unknown use but with potentially suitable habitat.
b DS=downstream orientation, L=left side, R=right side, W=width of the river, including islands.
c maps are included in the appendices.
d site is currently in the public domain.
e miles included in site 10.
f miles included in site 14.
g The Bluffs: all but 3 miles of the Bluffs are included in sites 1, 8, and 17; the bluff line ranges from 0.0-2.[illegible] km from the river.

be informed about programs designed to manage, protect, and acquire habitat for these species.

Habitat management

The three most important factors effecting protection, enhancement, and management of habitat important to the reproduction of least terns and piping plovers on the MNRR are: 1) inundation of colonies caused by untimely discharge of water from Gavins Point Dam, 2) vegetative encroachment of sandbars caused by the reduction of sandbar scouring due to long-term alterations of instream flows (U.S. Geological Survey 1983), and 3) human disturbance or destruction of nesting colonies caused by various recreational activities.

The Nebraska Game and Parks Commission (1985) suggests that careful management of water discharge from Gavins Point Dam by the COE could effectively reduce both the untimely inundation of nesting colonies and the vegetative encroachment of suitable habitat. The USFWS (1986) also suggests determination and coordination of discharge times and flow volumes in order to protect interior least terns and their habitat. The COE is currently preparing a biological assessment on the effects of Missouri River main stem dam operations on endangered species. This assessment will address how Gavins Point Dam flows can be managed to accommodate endangered species (Gorton pers. comm.).

The devegetation of higher elevation sandbars, portions of higher sandbars, and small islands in Priority I and II areas should provide least terns and piping plovers with suitable habitat. However, the effect of sandbar defoliation on other wildlife species should be considered. Cleared areas would be particularly important in high-water years (upper quartile or upper decile years) when Gavins Point discharge cannot be managed for wildlife as effectively as during average years (Nebraska Game and Parks Commission 1985).

Sandbars should be either physically (cutting, mowing, pulling, burning) or chemically (with approved chemicals) devegetated annually. Covering vegetated sandbars with dredge materials to smother existing vegetation and create suitable nesting sites may be possible. Bird acceptance and success on artificial sandbars is unknown, though least tern and piping plover nests have been reported in sandpits and dredge fill areas (Dinsmore 1981, Ducey 1981b). In order to establish colonies in average-water-level years, when more areas of suitable habitat are available, attraction techniques, such as decoying and playing back of recorded calls (Davis 1985), could be used.

It may be possible to create new habitat, i.e., sandbars, within the MNRR through the use of instream flow reduction devices, such as notched, culvert, and vane dikes, and subsurface structures (Burke and Robinson 1979, U.S. Army, Corps of Engineers 1986). The maintenance of these sandbars would depend on discharge management or other devegetation techniques. The management of existing habitat should be considered before the creation of new habitat.

Public use of sandbars supporting least tern and piping plover colonies should be controlled particularly from mid-May through August. Signs identifying least tern and piping plover adults, chicks, and nests, as well as their federal status and the penalty for their harrassment, should be posted at all public and private river accesses

and on colonial sandbars where feasible. The public should be urged to observe least terns and piping plovers only from a distance (>100 m) and preferably from boats (>50m).

The cottonwood-dogwood forest appears to be the most suitable habitat type for wintering bald eagle use on the MNRR. This forest type was given a high wildlife value (7.9 on a scale of 0--poor to 10--excellent) by Clapp (1977). Bald eagle wintering habitat suffers from three major problems on the MNRR: bank erosion, deforestation, and human disturbance. Bank erosion and deforestation are interrelated on the MNRR; erosion is often the result of deforestation and vice versa.

Bank erosion is one of the most severe problems effecting bald eagle habitat in the MNRR area. Erosion removes trees which are a necessary component of bald eagle winter habitat. One means of protecting such habitat from bank erosion is by the placement of revetments along critical portions of the river bank.

Deforestation by local landowners and woodcutters should be discouraged. The expansion of agriculture onto the flood plain is a major factor contributing to the loss of over 5,300 acres of cottonwood-dogwood habitat from 1944 to 1977 on the MNRR (USFWS 1979). Easements could be provided to landowners to set aside forests and thus protect the habitat. Another alternative could be acquisition, followed by management if needed. Also, property tax incentives could be proposed which would encourage landowners to preserve riparian habitat.

Human disturbance adversely effects bald eagle winter habitat use. Eagles often leave suitable areas when humans are present and are forced into less suitable habitats. When neccessary, human use of important eagle habitat should be limited during the wintering period. Posting, limiting access, or closing certain high use areas could help control human disturbances.

Public relations and education

Certain human activities negatively impact least tern, piping plover, and bald eagle behavior and habitats. Disturbances from all-terrain vehicles (ATV), fireworks, hikers, campers, sunbathers, fishermen, and pets may result in reduced nesting success and increased nest abandonment by least terns and piping plovers. Winter boat and snow mobile traffic and/or hunting and trapping activities may induce abandonment of perching and roosting sites by eagles. Disruptive activities should be restricted or eliminated in appropriate areas. However, a positive, non-threatening approach at public relations should be used whenever possible.

To explain the recreational restrictions, as well as the habitat needs of the least tern, piping plover, and bald eagle, four public relations measures are recommended.

1) Information to landowners and local residents Information in the form of newspaper, radio, and television advertisements, public presentations, and pamphlets would be an efficient way to make the public aware of efforts to save endangered species and their habitat on the MNRR. Many riverside residents have great respect for the

river and a protective attitude towards its wildlife inhabitants. This attitude can be utilized as an additional source of public education and habitat protection. Similar public relations methods have been effectively used on the MNRR by the Nebraska Game and Parks Commission (Dinan pers. comm.) and in North Dakota by the North Dakota Game and Fish Department (Kriel pers. comm.)

2) Posting of public and private ramps Most people access the river by way of public and/or private boat ramps. Installation of information boards at these areas would explain the needs of the endangered species and discourage habitat disturbance by recreationists during least tern and piping plover nesting periods (mid-May through late August) and bald eagle wintering periods (mid-November through late April).

3) Posting of specific sites: For least tern and piping plover habitat (sandbars), relatively permanent signs could be posted near low elevation sandbars on anchored buoys; long-term signs could be placed in areas with higher elevations. If buoys are not used on lower elevation sites, postings would have to be replaced periodically. For bald eagle habitat (upland forests and islands), long-term signs would suffice if maintainance is provided. The major problem with using signs is that they often attract people rather than keep them away. Therefore, posting at specific sites should explicitly define the penalties for harrassment of endangered or threatened species and disturbance of their habitat.

4) Production of a film and/or slide series A film or a slide series could be produced that would provide the general public with information in the form of entertainment. A film or a slide series could explain in great detail the needs and values of the MNRR and the endangered species which dwell there.

SUGGESTED RESEARCH

Annual surveys of breeding least terns and piping plovers, such as those previously conducted by the Nebraska Game and Parks Commission, should continue, and surveys of wintering bald eagles, conducted by the South Dakota Department of Game, Fish and Parks and the Nebraska Game and Fish Commission in cooperation with the National Wildlife Federation, should be expanded to include identification of specific use areas on the MNRR.

The MNRR provides a unique opportunity to study interior least terns and piping plovers in an area which retains many characteristics of the free-flowing Missouri River, but can be effected by water control structures. Sufficient background information has been collected by the Nebraska Game and Parks Commission and the South Dakota Department of Game, Fish and Parks to serve as base data for population and habitat investigations. The most urgent research needs pertain to methods for mitigating effects of unnatural water regimes. Examples of mitigation measures that entail sandbar and island management include manipulating discharge/flow level and cutting, burning, mowing, chemically removing, or smothering vegetation. Also, the effects that these management

efforts have on least tern and piping plover population size, nesting success, and site fidelity should be studied. The response of other wildlife species to management efforts should also be studied. Least tern and piping plover use of artificially created sandbars should also be assessed, but only if efforts to maintain and manage natural sandbars are insufficient. The effects of human disturbance on nesting success and nest site selection should be determined, and posting efforts should be evaluated.

Life history studies should address the following questions: how does site fidelity pertain to nesting success in previous years? Do breeding birds return to their natal colonies? What factors effect colony size (numbers of nesting birds) on the MNRR? Other studies should evaluate the foraging strategies and food habits of least terns and piping plovers, which feed primarily on fish (terns) and invertebrates (plovers). Abundance and distribution of forage fish and invertebrate populations, which could change as ephemeral in-channel river features (sub-channels, embayments, mud flats etc.) are altered due to changes in flow levels, should be evaluated. Wetland types in and around the MNRR should be inventoried using aerial photography, and least tern and piping plover use of the various wetland types should be determined.

More information is needed about the behavior and distribution of wintering bald eagles including determination of roosting and perching areas, foraging stategies, and movements. The effects of human disturbance on wintering bald eagles in the MNRR area should also be determimined since there seems to be a conflict between reported eagle sensitivity to human disturbance and their frequent use of high human-activity areas, i.e., dams. Habitat management efforts, such as forest preservation and posting, should be evaluated.

Bank stabilization might be attempted in Priority I areas subject to intensive erosion. However, the effects of stabilization on flow rates, riverine formations (backwaters, sandbars, side channels, etc.), upland habitat, and subsequently other wildlife and fish species, in and adjacent to the stabilized areas should be carefully considered (Burke and Robinson 1979). The Carl Mundt Eagle Refuge near Pickstown, South Dakota exemplifies a technique used to protect eagle habitat with minimal disturbance to upland habitat (Lengkeek pers. comm.).

The possibility of eagles successfully nesting in the MNRR area should be explored. Potential nesting habitat should be identified; if nesting habitat is adequate, attraction or introduction methods might be considered.

Environmental contaminants often end up in rivers and other waterways; these contaminants may accumulate in wildlife species that use rivers (Sowards 1984). If environmental contaminants are present in the MNRR, they may be particularly harmful to least terns, piping plovers, and bald eagles because of their relatively high positions in the food chain. Levels of contaminants have been measured in colonial nesting birds on two Missouri River tributaries in South Dakota (Sowards 1984), but no testing has been done in the MNRR. It may be possible to assess the potential danger of environmental contaminants to colonies of nesting least terns and piping plovers by collecting and analyzing eggs from unsuccessful nests (those washed out or abandoned). Contaminants could also be detected from bald eagle feathers.

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APPENDICES

Appendix A. Desription of least tern and piping plover nesting habitat sites on the MNRR (Priority designations in parentheses).

RM section 810-808 (III): No suitable or manageable habitat available. No sandbars are present and recreational use is very high.

RM section 808-806 (II): Two wooded islands; manageable sites are present but limited by vegetative encroachment; recreational use is very high and island are probably large enough to support predators year-around.

RM section 806-805 (III): No suitable or manageable habitat is present and recreational use is very high.

RM section 805-804 (Ia): One sandbar with historical colony use (successful in 1986, i.e., young may or may not have been produced, but the colony was not destroyed or abandoned); human use is high. One wooded island with no suitable habitat (down stream [ds] end of island is separated by shallow subchannel and contains manageable habitat).

RM section 804-803 (Ib): One sandbar on the ds end of wooded island with colonial use annually since 1982; colony destroyed in 1986 and all habitat inundated or encroached; devegetation should be considered.

RM section 803-798 (Ia): Seven historically used sympatric colonial sites and two historical piping plover colonies; all colonial sites were low and subject to inundation (4 colonies were unsuccessful, i.e., destroyed or abandoned) in 1986. Several higher sandbars with heavy encroachment exist at RM 801 and are recommended for devegetation. The area also contains James River Island which contains no suitable habitat. Human use is probably dispersed among the several sandbars and James River Island in this area.

RM section 798-797 (II): One narrow, wooded island on the SD side (RM 798) with no suitable habitat and a low sandbar complex (midstream at RM 797) with some suitable habitat, but most areas have heavy encroachment and are subject to inundation. Human use probably high because of the Cedar County Boat Ramp, NE.

RM section 797-796 (Ia): Four sites with historical use (one unsuccessful piping plover colony in 1986), all low and subject to inundation and encroachment. Bars near SD side are muddy and choked with cattails. Human use probably high.

RM section 796-795 (III): No sandbars present.

RM section 795-793 (Ia): Two major sandbar/island complexes on the NE side. Both have higher elevations and contain wooded areas and subchannels. There are two areas (on the upstream [us] and ds ends of the complexes) of suitable habitat and historical colonial use that are low and subject to inundation and encroachment. Inner complex is subject to ATV use.

RM section 793-792 (III): No suitable habitat; sandbars are choked with cattails.

RM section 792-791 (Ib): One heavily encroached sandbar with manageable habitat and historical use at midstream. Human use probably limited by distance to nearest boat ramp.

RM section 791-789 (Ia): Suitable sandbars at midstream (RM 790.5) with historical use are very low and subject to inundation but have little encroachment. A large complex of bars and subchannels on the SD side from RM 790.5-789.0 has several sand points, fingers of sand extending from sandbars, with suitable habitat (small piping plover colony in 1986). Many of the sandbars in this area are heavily

vegetated, and those closer to the SD shore are choked with cattails. Higher elevation areas in this complex are recommended for devegetation. Human use is probably dispersed along this complex.

RM section 789-784 (III): Sandbars above Bow Creek confluence are unsuitable because of their low elevation, and unsuitable sandbars directly below Bow Creek are narrow and heavily vegetated. Sandbars and small islands us and on both sides of Goat Island (to RM 784) are higher, wooded, and have no recorded historical use. Three sandbars on the NE side of Goat Island at RM 785 are subject to inundation at encroachment and contain no suitable habitat. Human use of this area is high.

RM section 784-780 (Ia): Two historical colonies (one successful, one unsuccessful in 1986) between Goat Island and SD; both are subject to heavy encroachment. Colony (unsuccessful in 1986) at RM 783.2 is higher but contained no suitable habitat in August of 1986 because of encroachment; this sandbar should be devegetated. Colony at RM 782.5 has only marginal habitat because of heavy encroachment, and it is subject to inundation. A third colony on the NE side at RM 781.5 is also low and subject to inundation. The sandbar complex near the SD side from RM 780-781 is heavily vegetated and contains no suitable habitat. All habitats within this section are subject to high human use because of the landings at Clay County Park, SD (RM 780.5) and Cedar County Public Access, NE (RM 784.5).

RM section 780-779 (III): No suitable habitat. Two small sandbars subject to inundation and encroachment.

RM section 779-776 (Ia): Two historical colonies and several areas of suitable and manageable habitat. Major sandbar complexes from RM 778.0-778.7 (successful 1986 colony on us-most sandbar) and from RM 776.7-777.6 (unsuccessful 1986 piping plover colony on ds-most sandbar) with all habitats subject to inundation and most with encroachment. Human use of this area is high.

RM section 776-775 (III): One historical site but not used since 1981, site now very small and heavily encroached. One other area with no suitable habitat.

RM section 775-773 (Ia): Two historical colony sites on low sandbars with suitbale habitat on the SD side (one successful least tern colony in 1986). Both sites are subject to inundation. Bars in backwater on SD side (RM 773.3) are muddy and choked with cattails.

RM section 773-772 (Ib): Two low, muddy sandbars, with some suitable habitat and historical use are present but subject to inundation.

RM section 772-769 (Ia): Five historical colony sites (two successful and one unsuccessful in 1986). Vermillion Island and another island (RM 771.1-771.6, toward the NE side and bifurcated by a subchannel) contain no suitable habitat and probably support predators year-around. Four of the historical colony sites still retain suitable habitat but are subject to encroachment and inundation. The sandbar between Vermillion island and the SD shore at RM 771, though not historically used, has a higher elevation and heavy encroachment and may be suitable for devegetation. Human use of all habitats in this areas is high because of the private boat landing at the Ponderosa Development, SD.

RM section 769-767 (Ib): One wooded island on the NE side contains no suitable habitat and is probably large enough to support predators year-around. A historical colony on the low sandbar with manageable habitat between this island and the NE shore (RM 768) is heavily encroached and

subject to inundation.

RM section 767-766 (Ia): A colony site (successful in 1986) on the sandbar complex at RM 766.0-766.2 contains the only suitable habitat in this section. Human use of this sandbar is particularly high.

RM section 766-765 (Ib): A heavily encroached sandbar at RM 765.1 has higher elevation and is recommended for devegetation. Other areas of manageable habitat, near the NE shore, are subject to predation and ATV use.

RM section 765-764 (Ia): One area of suitable habitat, subject to inundation on the SD side (unsuccessful colony in 1986). Higher areas adjacent to the colony are heavily vegetated and probably subject to predation and ATV use.

RM section 764-763 (III): No suitable habitat was available in 1986. Human use high because of Bolton State Game Production Area (GPA), SD and its landings.

RM section 763-761 (Ia): Four low suitable sandbars exist at midstream around RM 762. All are subject to inundation; one contained a colony which was destroyed by inundation in 1986.

RM section 761-760 (III): No suitable habitat is available; ATV and human use is high.

RM section 760-754 (Ia): Six historical colonies have been recorded; five areas of suitable habitat existed in 1986, including three colonies (two of which were destroyed by inundation). A high, wooded island (RM 760), which has been stabilized near the us end, provides some suitable habitat on the ds end. Two heavily vegetated sandbars on the SD side (RM 759.7) are recommended for devegetation. Several sandbars occur from RM 758.5-759.6 and are suitable for least tern and piping plover nesting (the sandbar at RM 758.5 had an unsuccessful colony in 1986); but, all of these sandbars are subject to inundation and encroachment. Three low sandbars with suitable habitat (RM 756.6) are also subject to inundation; one of these sandbars, a long narrow bar near the NE shore, supported an unsuccessful piping plover colony in 1986. The sandbar complex on the SD side from RM 757-759 is heavily vegetated and receives heavy ATV traffic from the Warren GPA (also called the Dunes). The only successful colony in this area in 1986 occurred on a large sandbar above the wooded island at RM 775. This bar contains much suitable habitat, but much of the sandbar is subject to inundation. The island contains some suitable habitat, but human use of the island and the adjacent sandbar is high because of the Ponca State Park, NE boat landing (RM 753.5).

RM section 754-752 (III): No suitable habitat exists and human use is very high.

Appendix B. Description of bald eagle wintering habitat sites on the MNRR.

Of the seventeen designated sites, six were noted as already being in the public domain, they include sites: 1 (Lake Yankton etc.), 6 (Myron Grove GPA), 9 (Clay Co. Park), 11 (Frost Wilderness area), 15 (Bolton GPA), and 17 (Ponca State Park). Since these sites are already owned by federal, state, county, or city governments, they might be considered differently than the privately owned sites. Of these sites, 1, 6, and 11 were designated as Priority I, 9 and 15 as Priority II, and 17 as Priority III.

Site 7 was unique in the Priority III class since it represents the bluffs. These bluffs often act as the downstream right bank of the river. Three other sites were classified as Priority III areas, they include sites 10, 13, and 16. Although eagles have been sighted in these areas, numbers of eagles using them have been low and scattered. Therefore, further surveys in these areas should be undertaken before any acquisition is considered.

Sites 2, 3, and 13 have been classified as Priority II areas (also those in the public domain). These are areas of relatively high eagle use with varying degrees of human use, erosion, and bank stabilization, and should be acquired if possible.

Three sites have been classified as Priority I areas. The prioriority I designation signifies that these sites have a high recorded incidence of eagle winter use. It does not imply that the areas are free of erosion or human use. It is recommended that, to the extent possible, these sites be acquired by the Federal Government.

The first and most important of the Priority I sites is number 4. This site includes the James River Island and the adjacent SD and NE floodplains. As mentioned before, the James River Island provides the only known roost site in the MNRR area. In addition, this area provides some of the most utilized eagle feeding and loafing habitat in the MNRR area.

Sites 5 and 8 are also Priority I areas. Site 5 includes much of the Audubon Bend, Saint Helena Bend and the reach between them. Site 8 includes Goat Island and its adjacent SD and NE floodplains (also known as Hill Reach). These three sites are highly recommended for acquisition.